FINAL Report

Modeling TDM Effectiveness:

Developing a TDM Effectiveness Estimation Methodology (TEEM) and Case Studies for the SR 520 Corridor

Part of the
Implementing Corridor TDM Programs in the Puget Sound Region Project

APPENDIX C
Documentation of the TEEM Software

Prepared for

Washington State Department of Transportation

In cooperation with U.S. Department of Transportation – Federal Transit Administration

Prepared by
***DKS** Associates*
1956 Webster Street, Suite 300
Oakland, CA 94612
(510) 763-2061

In association with
Mirai Associates

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Appendix C

Documentation of the TEEM Software

B.1 Structure of the TEEM Software

The TEEM software is set up to evaluate fifteen different TDM or land use strategies. In the order they are set up in the software they are as follows:

1. **Vanpool Programs**
2. **Alternative Mode Subsidy**
3. **CTR-Type Programs for Small Employers**
4. **Telecommuting**
5. **Compressed Work Week**
6. **Multi-Employer Ridesharing Coordination Program**
7. **Increased Density Near Transit**
8. **Encourage Mixed-Use Development**
9. **Encourage Infill Development and Densification**
10. **Bicycle Lanes or Paths**
11. **Provide Pedestrian Facilities**
12. **Restricted Parking Supply**
13. **Parking Pricing at Employment Sites**
14. **FlexPass/Residential Pass**
15. **Increased Density Near Transit**

The first worksheet in the TEEM Excel workbook is labeled **Read Me**. You can find this sheet by looking at the bottom of the screen and clicking on the words **Read Me**. This first sheet will let you know what the different colors mean in the remaining sheets. Light pink cells are row or column labels, and should not be changed. Two shades of orange are used to indicate that the values in these cells are part of the TEEM model and are not to be modified by the user. These cells are protected and cannot be changed without removing the protection. Two shades of blue are used to identify cells that are modified as part of the model set up. These include data inputs and sensitivity factors. Values in these cells will usually remain unchanged after the model is set up and should be modified only by an advanced user if more accurate data on travel study area development, travel patterns or sensitivity to strategies becomes available. Cells that are white represent the required input from the user. In these cells the user is to specify the strategies to be tested.

The second and third worksheets in the workbook are labeled **Testing Strategies** and **Testing Land Use**. These are the only sheets that you will need to use once TEEM has been set up for a study area. The **Testing Strategies** sheet will prompt you for the input that TEEM needs to describe a strategy. This one worksheet contains all of the input screens for twelve of the fifteen strategies. The Testing Land Use sheet contains the input screen for the other

three strategies. More than one strategy can be tested at a time, including combination of strategies from both of the sheets. Whenever more than one strategy is tested, the output of TEEM will represent the combined estimated effect of all of the strategies tested. The effect of individual strategies can only be tested by applying the software with only the one strategy specified.

The fourth worksheet in TEEM is labeled **Model Input**. This worksheet is designed to hold local-area model data describing the population, employment and trip patterns of the local model zones in the study area. In setting up TEEM for a study area, the data in this worksheet should be supplied for a base year and for a forecast year. Several of the strategies are designed to estimate effectiveness of strategies based on the characteristics of development and trip patterns for small sub-areas with a study area. The worksheet will use data at the smallest level of zone definition available to the user, but this will normally be the traffic analysis zones used in a local travel model.

Additional travel information usually derived from a travel model is also required in TEEM. This is information on mode shares for each trip type: work trips and non-work trips. This information is requested in the worksheet labeled **Mode Shares**. The mode shares for work trips must be specified for each analysis year for the total employment in a study area and the CTR employment (employers with more than 100 employees.) The CTR employment mode shares are available in King County from the CTR database.

The worksheet labeled **Mode Shares** is also an output screen. In addition to the starting mode shares, the worksheet reports the final estimated mode shares that would result from the strategies tested.

The final thirteen worksheets in TEEM are the sheets on which the actual calculations of the strategy effectiveness are conducted. The worksheets are labeled according to the strategy numbering above. For example, the worksheet label **S1** corresponds to **Strategy 1 – Vanpool Programs**. Some of the strategies are combined in worksheets because they operate off of the same data. Three strategies related to land use are combined: **Strategy 7 - Increased Density Near Transit**, **Strategy 8 - Encourage Mixed-Use Development**, and **Strategy 9 - Encourage Infill Development and Densification**. These are combined in worksheets labeled **S7S8S9-1** and **S7S8S9-2**. Similarly, the two strategies related to improving walk and bicycle access are combined in a single worksheet labeled **S10S11**. They are **Strategy 10 - Bicycle Lanes or Paths** and **Strategy 11 - Provide Pedestrian Facilities**.

Many of the strategies in TEEM are employer-based programs and affect only work trips. The calculations for these strategies affect either the mode shares or frequency of work trips. They are:

- Vanpool Programs
- Alternative Mode Subsidy
- CTR-Type Programs for Small Employers
- Multi-Employer Ridesharing Program
- Telecommuting
- Compressed Work Week
- Parking Pricing at Employment Sites

Three other strategies related to facilitating non-motorized travel might affect both work and non-work trips if implemented, but only the effect on work trips is included in TEEM, because of the limitation of data on effectiveness for non-work trips. These strategies are as follows:

- Bicycle Lanes or Paths
- Provide Pedestrian
- Develop Interconnected Street Network

The remaining five strategies can affect the frequency or mode shares for both work and non-work trips. These strategies are as follows:

- FlexPass Program
- Restricted Parking Supply
- Increased Density Near Transit
- Encourage Mixed-Use Development
- Encourage Infill Development and Densification

For more detail on how TEEM calculates the potential effectiveness of each strategy, refer to the descriptions of the methodologies for the individual strategies later in this document. The documentation of strategies covers each of the following areas:

- Strategy Parameters
- Effectiveness Factors
- Baseline Information
- Sensitivity Factors
- User Inputs
- Calculation of Strategy Effect
- Research Used to Support Calculation of Effectiveness
- Factors Not Accounted For
- Assumptions

Operating Instructions

Once TEEM has been set up for a study area, all of the values in light blue cells have been filled in, the software can be used by simply specifying the information in the worksheet marked **Testing Strategies**. For strategies 7, 8, and 9; the user clicks the gray box next to the strategy names, and provides the information needed to specify the strategy directly into another worksheet: **Testing Land Use**. All other strategies are specified in the **Testing Strategies** worksheet. As soon as inputs are entered for a strategy or combination of strategies, the calculations of effects are made. Once all of the inputs are entered for the desired strategies, the results on mode shares can be checked in the worksheet labeled Mode Shares. (Work is still in progress on a worksheet that will provide a summary of the all of the performance measures.)

B.2 Description of Methodology for Specific Strategies

1. Vanpool Program

This strategy includes organized, promoted and subsidized vanpool program offered to an additional increment of employees within a study area above and beyond the employees that would already be offered the vanpool program in the baseline condition for 2030. The increment of employees may come from new employers offering programs to employees for the first time or from employers who already offer vanpooling to some employees offering it to more employees. The subsidy is assumed to be the same as the average 2001 subsidy by CTR employers (organized by number of employees) that indicated that they provide a subsidized vanpool program.

Strategy Parameter

The strategy is tested by specifying the percentage of employees within a study area that would be offered the full package of vanpool support and subsidy that had not been offered a program before. The percentage can be specified for all employees or can be specified by employer size (0-99, 100-499, 500+). A vanpool subsidy in excess of the average offered by the CTR employers can be tested in Strategy #2 – Alternative Mode Subsidy.

Effectiveness Factor

The effectiveness factor for this strategy was derived from analysis of the effectiveness of vanpool program in King County for CTR employers who offered a program for the first time after entering the CTR program.

Sensitivity Factors

- Average participation rate (1-99 employees). Default: 0.5%
  - *Input sheet name: "S1"*
- Average participation rate (100-499 employees). Default: 1.3%
  - *Input sheet name: "S1"*
- Average participation rate (500+ employees). Default: 2.4%
  - *Input sheet name: "S1"*

Calculation of Strategy Effect

- Use average participation rate among employees offered vanpooling by size of employer to calculate shift in vanpooling

Baseline Information

Collected at the Transportation Analysis Zone (TAZ) Level:

- Baseline mode split for HBW attractions
  - *Input sheet names: "2000" and "2030"*

Collected at the Case Study Area Level:

- Total number of employees by size of employer
  - *Input sheet name: "Employee Distribution Input"*
- Baseline mode split for CTR employers

- *Input sheet name: "Mode Split Input"*

Collected at the Regional Level:

- None

User Inputs

- Change in the percent of employees offered a subsidized and promoted vanpool program
  - *Input sheet name: "Test"*

Research Used to Support Calculations of Effectiveness

- Evidence of variation of vanpool participation by employer size
- Vanpool market study information

Factors Not Taken Into Account

- Transit service and baseline transit mode share
- Employer or employee type

Assumptions

- The decrease in auto drive alone mode share is proportional to baseline mode shares
- Vanpooling is a viable option for all employees

2. Alternative Mode Subsidy

This strategy will include a direct subsidy paid by the employer to the employee for commute modes other than "Drive Alone". This may include transit, vanpooling, carpooling, bicycling or walking.

Strategy Parameter

The strategy is tested by specifying a daily round-trip subsidy to be offered and the percentage of employees that would be offered the subsidy. This is not the percentage of employees that would accept the subsidy, but only the number that would be offered a subsidy that were not offered one before.

Effectiveness Factor

The effectiveness factors (one for each mode) for this strategy were taken from national research on price elasticities by mode. Price elasticity is the percentage change in mode use that would result from each one-percent change in price or far for that mode. For example, the price elasticity that is used for carpooling is -0.15. That indicates that a one-percent reduction in the cost of carpooling would result in a 0.15 percent increase in carpool use.

Sensitivity Factors

- Elasticity of carpool use cost in reduction in carpool use. Default: -0.15
  - *Input sheet name: "S2"*
- Elasticity of vanpool use cost in reduction in vanpool use Default: -0.15
  - *Input sheet name: "S2"*

- Elasticity of transit use cost in reduction in transit use. Default: -0.22
  - *Input sheet name: "S2"*
- Change in drive-alone mode share with a non-motorized subsidy (Not an elasticity). Default: 2.7%
  - *Input sheet name: "S2"*

Calculation of Strategy Effect

- Use elasticities of mode use with respect to cost for each mode for work trips to calculate change in work mode shares

Baseline Information

Collected at the Transportation Analysis Zone (TAZ) Level:

- Baseline mode split for HBW attractions
  - *Input sheet names: "2000" and "2030"*

Collected at the Case Study Area Level:

- Average one-way distance to work for drive alone, carpool and vanpool users
  - *Input sheet name: "Daily Cost Input"*
- Existing and future parking costs for drive alone, carpool and vanpool vehicles
  - *Input sheet name: "Daily Cost Input"*

Collected at the Regional Level:

- Cost per mile to drive vehicles and vanpools
  - *Input sheet name: "Daily Cost Input"*
- Average number of people per carpool and vanpool vehicle
  - *Input sheet name: "Daily Cost Input"*
- Average daily cost to ride transit
  - *Input sheet name: "S2"*

User Inputs

- Percent of employees offered a carpool, vanpool, transit or non-motorized subsidy program
  - *Input sheet name: "Test"*
- Cost of subsidy by mode
  - *Input sheet name: "Test)*

Research Used to Support Calculations of Effectiveness

- Price elasticity by mode by using national data, the PSRC model, or directly reported experiences (vanpool market study)

Factors Not Taken Into Account

- Alternative mode availability
- Trip length

Assumptions

- The decrease in auto drive alone mode share is proportional to baseline mode shares
- Changes apply proportionally to employees within CTR and non-CTR employers

3. CTR-Type Programs for Non-CTR Affected Employers

This strategy will include providing non-CTR affected employers with planning, reporting and monitoring support to support meeting the goals of Washington's Commute Trip Reduction law. This strategy will include only a planning, reporting and monitoring program and not any of the services or subsidies that might be offered by or through the employer to support meeting the CTR goals.

Strategy Parameter

The strategy is tested by specifying the number of employees that would be covered by a CTR-like program for employers with 50 to 99 employees.

Effectiveness Factor

The effectiveness factor for this strategy was derived from an analysis of the CTR program effectiveness for employers with 100 or more employees. The analysis indicated that companies in the CTR program eventually achieved an average drive-alone share reduction of 5.9% (from companies that have been in the program for all 10 years). Although other national research has suggested that the average effectiveness for employers with less than 100 employees is roughly half of what was achieved by employers with 100 or more employees, there was no clear evidence that potential effectiveness was a function of employer size in the CTR database. Analysis of a small number of smaller employers voluntarily participating in the CTR program also indicated that smaller employers often did just as well if not better than large employers at reducing the drive-alone share for commute trips. As a result of this local research, no reduction in effectiveness will be made for smaller employers.

Sensitivity Factors

- Percent reduction in drive alone mode share with a CTR Program. Default: 5.9%
  - *Input sheet name: "S3"*
- Small employer effectiveness factor. Default: 100%
  - *Input sheet name: "S3"*

Calculation of Strategy Effect

- Calculate change in work mode shares based on the observed effects of the past CTR program.

Baseline Information

Collected at the Transportation Analysis Zone (TAZ) Level:

- Baseline mode split for HBW attractions
    - *Input sheet names: "2000" and "2030"*

Collected at the Case Study Area Level:

- Baseline mode split for CTR employers
    - *Input sheet name: "Mode Split Input"*

Collected at the Regional Level:

- None

User Inputs

- Offer a CTR-type program for small employers (50-99 employees)
    - *Input sheet name: "Test"*

Research Used to Support Calculations of Effectiveness

- CTR Program Effectiveness as reported for employers with 100+ employees

Factors Not Taken Into Account

- Type of employer
- Alternative mode availability
- City, TMA or other outside support (Ridematching, subsidy to employers for programs, TDM fares, outside marketing effort…) that may already be in place for smaller employers

Assumptions

- The decrease in auto drive alone mode share is proportional to baseline mode shares
- Assumes that mode share benefits gained by companies with over 100 employees will directly apply to companies with 50 to 100 employees

4. Telecommuting

This strategy will include allowance by employers for employees to work at home for one or more days a week. The strategy will assume that employees use their own personal computer, telephone and other equipment at home and provide their own Internet service provider or other service necessary to communicate from home.

Strategy Parameter

The strategy is tested by specifying the number of employees that would be offered the opportunity to telecommute one or more days per week who had not been offered the opportunity before.

Effectiveness Factor

The effectiveness factor for this strategy was developed from the CTR database by examining the participation rates for telecommuting at employment sites where the employer offered the program.

Sensitivity Factors

- Factor of additional users with a telecommute program. Default: 0.0096
  - *Input sheet name: "S4"*
- Probability of telecommuting by day of week. Default minimum is Monday at 17.2%
  - *Input sheet name: "S4"*

Calculation of Strategy Effect

- Use the reported participation rates among employees offered telecommuting to calculate participation among new employees offered telecommuting.
- Apply the same patterns among the new participants as observed for the telecommuters in the CTR database: days per week worked at home, days of week worked at home.

Baseline Information

Collected at the Transportation Analysis Zone (TAZ) Level:

- Baseline mode split for HBW attractions
  - *Input sheet names: "2000" and "2030"*

Collected at the Case Study Area Level:

- Baseline mode split for CTR employers
  - *Input sheet name: "Mode Split Input"*

Collected at the Regional Level:

- None

User Inputs

- Percent of employees offered a telecommute program
  - *Input sheet name: "Test"*

Research Used to Support Calculations of Effectiveness

- Distribution of days that people telecommute
- Program effectiveness (number of telecommuters per day from employers who offer a program)

Factors Not Taken Into Account

- Employee or employer type

Assumptions

- The decrease in auto drive alone mode share is proportional to baseline motorized mode shares
- Change in the number of telecommuters is proportional to employees within CTR and non-CTR employers

5. Compressed Work Week

This strategy will include employers allowing employees to complete a full work period in less than the number of regular workdays during that period. Two types of compressed work weeks will be analyzed: 4/40, in which a full work week is completed in four work days and 9/80, in which two full work weeks are completed in nine work days.

Strategy Parameter

The strategy is tested by specifying the number of employees that would be offered the opportunity to work a compressed work week who had not been offered the opportunity before.

Effectiveness Factor

The effectiveness factor for this strategy was developed from the CTR database by examining the compressed work week participation rates at employment sites where the employer offered the program.

Sensitivity Factors

- Factor of additional users with a compressed work week program. Default: 0.0683
  - *Input sheet name: "S5"*
- Probability of using a compressed work week by day of week. Default minimum is Tuesday at 12%
  - *Input sheet name: "S5"*

Calculation of Strategy Effect

- Use the reported participation rates among employees offered compressed work week to calculate participation among new employees offered compressed work week
- Apply the same patterns among the new participants as observed for the compressed work week participants in the CTR database: days per week worked, days of week not worked.

Baseline Information

Collected at the Transportation Analysis Zone (TAZ) Level:

- Baseline mode split for HBW attractions
  - *Input sheet names: "2000" and "2030"*

Collected at the Case Study Area Level:

- Baseline mode split for CTR employers
  - *Input sheet name: "Mode Split Input"*

Collected at the Regional Level:

- None

User Inputs

- Percent of employees offered a compressed work week program
  - *Input sheet name: "Test"*

Research Used to Support Calculations of Effectiveness

- Distribution of days that people use a compressed work week
- Program effectiveness (number of people per day from employers who offer a program)

Factors Not Taken Into Account

- Employee or employer type
- Number of people who make trips when they don't work

Assumptions

- The decrease in auto drive alone mode share is proportional to baseline motorized mode shares
- Change in the number of telecommuters is proportional to employees within CTR and non-CTR employers

6. Multi-Employer Ridesharing Program

This strategy will include an employee transportation coordinator (ETC) working with the multiple companies, ridesharing promotional materials, and coordination of ride-matching services with Metro and other regional agencies that provide ride matching.

Strategy Parameter

The strategy is tested by specifying the number of employees who would be covered by a multi-employer TMA in each employer-size category

Effectiveness Factor

The effectiveness factor for this strategy was developed by comparing the CTR effectiveness for CTR employers in Bellevue and Redmond who were members of a multi-employer TMA with CTR employers from those cities who were not in a TMA. The results indicated that the CTR employers in the TMAs were more effective in reducing drive-alone mode share by a factor of 1.18. When the strategy is applied in TEEM, the drive alone reduction for multi-employer TMA is -6.4 percentage point reduction in the drive-alone share over and above what is achieved through the CTR program.

Sensitivity Factors

- Percent reduction in drive alone mode share with a CTR Program (applied to small employers). Default: 5.9%
  - *Input sheet name: "S6"*
- Coordination effectiveness factor. Default: 118%
  - *Input sheet name: "S6"*

Calculation of Strategy Effect

- For non-CTR employers, calculate the change in work mode shares based on the observed effects of the past CTR program and a TMA program

For CTR employers, calculate the change in work mode share based on the observed effects of a TMA program

Baseline Information

Collected at the Transportation Analysis Zone (TAZ) Level:

- Baseline mode split for HBW attractions
  - *Input sheet names: "2000" and "2030"*

Collected at the Case Study Area Level:

- Total number of employees by size of employer
  - *Input sheet name: "Employee Distribution Input"*
- Baseline mode split for CTR employers
  - *Input sheet name: "Mode Split Input"*

Collected at the Regional Level:

- None

User Inputs

- Percent of CTR and non-CTR employees offered a rideshare program
  - *Input sheet name: "Test"*

Research Used to Support Calculations of Effectiveness

- Analyzed effectiveness of TMAs from Bellevue, Redmond, Seattle, SeaTac and Issaquah

Factors Not Taken Into Account

- May not include logical TMA units, such as hospital related employees in Totem Lake

Assumptions

- The decrease in auto drive alone mode share is proportional to baseline mode shares

7. Increased Density Near Transit

This strategy includes an increase in the previously assumed densities along bus routes, near regional transit centers or near future high capacity transit stations. The traffic analysis zones (TAZs) for the case study areas are all classified in one of six categories based on the number of routes that area within a quarter mile of the TAZ: High-1, High-2, Medium-1, Medium-2, Low-1 and Low-2. The definitions for the classifications levels are as follows:

- High-1: At least one (1) rail route or five (5) or more high frequency routes
- High-2: Four (4) high frequency routes or at least fifteen (15) total routes
- Medium-1: Three (3) high frequency routes or at least ten (10) total routes
- Medium-2: Two (2) high frequency routes or at least five (5) total routes
- Low-1: At least two (2) total routes
- Low-2: Less than two (2) total routes

High frequency routes are defined as routes with four or more buses per hour.

Strategy Parameter

The strategy is tested by specifying the amount of new growth within each study area (between 2000 and 2030) that should be redistributed to traffic analysis zones in the study are with high transit level of service. The percent of new growth in zones with medium and low transit service that is to be reallocated is specified by the user.

Effectiveness Factor

The effectiveness factor for this strategy was developed using a cross-sectional analysis of data for 2000 for all of the traffic analysis zones in four-county Puget Sound Region. A similar approach was taken to develop effectiveness factors for the other land-use strategies (#8, #9 and #15). Three categories were used to describe the other two land use characteristics. Tables were developed to provide an index of vehicle trip rates for differences between zones with different classifications according to the three land use characteristics. A three-way table (6x3x3) was developed for commute trips by employees working in the zone and that is provided in Table B-1. When evaluating the effect of mixed use on total vehicle trips for people living in a zone, no meaningful relationship was found.

Table B-1
Land Use Classification

Density	Transit Service	Mixed Use		
		High	Medium	Low
High	High-1	1.00	1.01	1.05
	High-2	1.02	1.04	1.08
	Medium-1	1.05	1.06	1.11
	Medium-2	1.06	1.07	1.12
	Low-1	1.08	1.09	1.15
	Low-2	1.08	1.09	1.15
Medium	High-1	1.01	1.02	1.07
	High-2	1.04	1.05	1.10
	Medium-1	1.06	1.08	1.13
	Medium-2	1.07	1.09	1.14
	Low-1	1.10	1.11	1.17
	Low-2	1.10	1.11	1.17
Low	High-1	1.07	1.08	1.13
	High-2	1.10	1.11	1.17
	Medium-1	1.13	1.14	1.20
	Medium-2	1.14	1.15	1.22
	Low-1	1.16	1.18	1.25
	Low-2	1.17	1.19	1.25

To illustrate how the table works, a zone with Medium-1 transit service, is medium density and is medium in mixed-use, has a vehicle trip rate for commute trips by study are employees that is 1.052 times (5.2% greater than) that of a zone with High-2 transit service, medium density and medium mixed use: 1.08/1.02 = 1.052.

Sensitivity Factors

- Variation in vehicle trips by population, retail employment, and other employment density
    - *Input sheet names: "Land Use Factors"*

Calculation of Strategy Effect

- Calculate revised future year trip ends by purpose for each local traffic analysis zone using the appropriate rates by transit service, density and mix use ratio categories
- Includes a calculation of associated centroids to estimate the transit service, mixed-use and density of nearby zones

Baseline Information

Collected at the Transportation Analysis Zone (TAZ) Level:

- Baseline mode split for HBW attractions and HBW productions
    - *Input sheet names: "2000" and "2030"*
- Transit level of service
    - *Input sheet names: "2000" and "2030"*
- Area in square miles
    - *Input sheet names: "2000" and "2030"*
- Population, retail employment and other employment
    - *Input sheet names: "2000" and "2030"*

Collected at the Case Study Area Level:

- Baseline mode split for CTR employers
    - *Input sheet name: "Mode Split Input"*

Collected at the Regional Level:

- None

User Inputs

- Percent of growth that should be redistributed to high transit zones
    - *Input sheet name: "Test"*

Research Used to Support Calculations of Effectiveness

- Calculation of transit level of service factors for each TAZ based on existing person trips and the existing transit service

Factors Not Taken Into Account

- Non-work trips
- Nature of employment

Assumptions

- The decrease in auto drive alone mode share is proportional to baseline mode shares
- The radius of effectiveness for a TAZ is approximately 1/4 mile beyond its area

8. Encourage Mixed-Use Development

This strategy alters existing land use forecasts to reflect a greater mix of complementary land uses within the case-study areas. Complementary land uses are considered to be those that together reduce vehicle trip demand while not reducing person trip demand. This includes mixing of residential land use with commercial land use to provide residents with employment and shopping within a short distance. The traffic analysis zones for the case study areas are all classified as high, medium or low based on an index that reflects variance between the share of total development in a zone that is residential, retail, and other commercial. The formula for land use mix index is as follows:

MUI = ((Pop/2 +REMP + OEMP)/3)/(Standard Deviation of Pop/2, REMP, OEMP)

Where: MUI – Mixed Use Index
Pop – TAZ Population
REMP – TAZ Retail Employment
OEMP – TAZ Other Employment

The definitions for the classification levels are as follows

High: MUI > 2
Medium: Between High and Low
Low: MUI < 1

The population, retail employment growth and other employment growth are redistributed with this strategy based on a "density factor" that is calculated to be:

population/2 + retail employment + other employment)/area

Strategy Parameter

The strategy is tested by specifying the amount of new growth within each study area (between 2000 and 2030) that should be redistributed to traffic analysis zones in the study are in order to better balance out the mixed-use of the case study area. The percent of new growth to be reallocated is specified by the user.

Effectiveness Factor

The effectiveness factor for this strategy was developed using a cross-sectional analysis of data for 2000 for the traffic analysis zones in King County. The effect of mixed use on vehicle trip rates is shown in Table B-1.

Sensitivity Factors

- Variation in vehicle trips by population, retail employment, and other employment mixed-use
    - *Input sheet names: "Land Use Factors"*

Calculation of Strategy Effect

- Calculate revised future year trip ends by purpose for each local traffic analysis zone using the appropriate rates by transit service, density and mix use ratio categories
- Includes a calculation of associated centroids to estimate the transit service, mixed-use and density of nearby zones

Baseline Information

Collected at the Transportation Analysis Zone (TAZ) Level:

- Baseline mode split for HBW attractions and HBW productions
  - *Input sheet names: "2000" and "2030"*
- Transit level of service
  - *Input sheet names: "2000" and "2030"*
- Area in square miles
  - *Input sheet names: "2000" and "2030"*
- Population, retail employment and other employment
  - *Input sheet names: "2000" and "2030"*

Collected at the Case Study Area Level:

- Baseline mode split for CTR employers
  - *Input sheet name: "Mode Split Input"*

Collected at the Regional Level:

- None

User Inputs

- Percent of growth that should be redistributed to increase mixed-use
  - *Input sheet name: "Test"*

Research Used to Support Calculations of Effectiveness

- Calculation of mixed-use factors for each TAZ based on existing person trips and the existing mixed-use of an area

Factors Not Taken Into Account

- Non-work trips
- Nature of employment

Assumptions

- The decrease in auto drive alone mode share is proportional to baseline mode shares
- The radius of effectiveness for a TAZ is approximately 1/4 mile beyond its area

9. Encourage Infill Development and Densification

The strategy assumes an increase in the previously assumed land-use forecasts to concentrate more employment and higher density housing in the existing activity or urban centers within each study area.

Strategy Parameter

The population growth, retail employment growth and other employment growth are redistributed in this strategy based on a "density factor" that is calculated to be:

population/2 + retail employment + other employment)/area

the user specifies the percent of zones that should receive additional population, retail employment, and other employment growth (example: 20%). The user specifies the percent of growth that is to be shifted from the "small density" TAZs to the "high density" TAZs within the study area (example: 50%). This strategy redistributes the growth from the lowest ot eh highest zones based on the density factor.

Effectiveness Factor

The effectiveness factor for this strategy was developed using a cross-sectional analysis of data for 2000 for the traffic analysis zones in King County. The effect of density on vehicle trip rates is shown in Table B-1.

Sensitivity Factors

- Variation in vehicle trips by population, retail employment, and other employment density
    - *Input sheet names: "Land Use Factors"*

Calculation of Strategy Effect

- Calculate revised future year trip ends by purpose for each local traffic analysis zone using the appropriate rates by transit service, density and mix use ratio categories
- Includes a calculation of associated centroids to estimate the transit service, mixed-use and density of nearby zones

Baseline Information

Collected at the Transportation Analysis Zone (TAZ) Level:

- Baseline mode split for HBW attractions and HBW productions
    - *Input sheet names: "2000" and "2030"*
- Transit level of service
    - *Input sheet names: "2000" and "2030"*
- Area in square miles
    - *Input sheet names: "2000" and "2030"*
- Population, retail employment and other employment
    - *Input sheet names: "2000" and "2030"*

Collected at the Case Study Area Level:

- Baseline mode split for CTR employers
  - *Input sheet name: "Mode Split Input"*

Collected at the Regional Level:

- None

User Inputs

- Percent of growth that should be redistributed to increase density
  - *Input sheet name: "Test"*

Research Used to Support Calculations of Effectiveness

- Calculation of density factors for each TAZ based on existing person trips and the existing density of an area

Factors Not Taken Into Account

- Non-work trips
- Nature of employment

Assumptions

- The decrease in auto drive alone mode share is proportional to baseline mode shares
- The radius of effectiveness for a TAZ is approximately 1/4 mile beyond its area

10. Bicycle Lanes or Paths

This strategy assumes an increase in the network of bicycle routes (a combination of bicycle lanes in the street right-of-way and separate off-road paths). The analysis of this strategy is based on an assessment of how comprehensively the study area is connected via safe and pleasant bicycle routes or paths with the area within six miles of the outer edges of the study area. An increase in bicycle connectivity can also result from increasing the street connectivity in or around the study area, which can create new bicycle routes. The assessment is largely a subjective one and is designed to relate the situation being tested for the study area to maximum bicycle route/path connectivity in the Puget Sound Region.

Strategy Parameter

The strategy is tested by specifying the percentage increase in bicycle route/path coverage that is proposed. Again, the percentage is designed to be the amount of movement toward the maximum level of coverage provided anywhere in the region and is also a subjective assessment.

Effectiveness Factor

The effectiveness factor for this strategy was derived by identifying the 85th percentile bicycle commute mode share from the CTR database (2.03%) and assuming that the coverage for this employer is roughly 85%. This yielded an effectiveness factor of 0.24% reduction in commute drive alone share from each 10% increase in bicycle route/path connectivity.

Sensitivity Factors

- None

Calculation of Strategy Effect

- Calculate the revised non-motorized mode share by applying an increase toward the maximum percent of bicycle mode share that can be expected

Baseline Information

Collected at the Transportation Analysis Zone (TAZ) Level:

- Baseline mode split for HBW attractions and HBW productions
  - *Input sheet names: "2000" and "2030"*

Collected at the Case Study Area Level:

- None

Collected at the Regional Level:

- Maximum potential for bike trips. Default: 2.4%
  - *Input sheet name: "S10S11"*

User Inputs

- Percent of additional bicycle coverage
  - *Input sheet name: "Test"*

Research Used to Support Calculations of Effectiveness

- Percent of employees who bicycle to work from the CTR database

Factors Not Taken Into Account

- Length of work trip
- Possible limit to work trips
- Existing bicycle and walking use
- Weather, seasons, climate

Assumptions

- The decrease in auto drive alone mode share is proportional to baseline mode shares
- The 85 percentile of bicycling mode share from the CTR database represented 85 percent of the bicycle mode share that can be expected

11. Provide Pedestrian Facilities

This strategy includes an network of sidewalks and trails and other pedestrian facilities. The analysis of this strategy is based on an assessment of how comprehensively the study area is connected via safe and pleasant sidewalks or other pedestrian facilities with the area within one mile of the outer edges of the study area. An increase in pedestrian connectivity can also result from increasing the street connectivity in or around the study area, which can create new pedestrian routes. The assessment is largely a subjective one and is designed to relate the situation being tested for the study area to the maximum pedestrian connectivity in the Puget Sound Region.

Strategy Parameter

The strategy is tested by specifying the percentage increase in pedestrian coverage that is proposed. Again, the percentage is designed to be the amount of movement toward the maximum level of coverage provided anywhere in the region and is also a subjective assessment.

Effectiveness Factor

The effectiveness factor for this strategy was derived by identifying the 85th percentile pedestrian commute mode share from the CTR database (4.27%) and assuming that the coverage for this employer is roughly 85%. This yielded an effectiveness factor of 0.50% reduction in commute drive alone share from each 10% increase in bicycle route/path connectivity.

Sensitivity Factors

- None

Calculation of Strategy Effect

- Calculate the revised non-motorized mode share by applying an increase toward the maximum percent of pedestrian mode share that can be expected

Baseline Information

Collected at the Transportation Analysis Zone (TAZ) Level:

- Baseline mode split for HBW attractions and HBW productions
    - *Input sheet names: "2000" and "2030"*

Collected at the Case Study Area Level:

- None

Collected at the Regional Level:

- Maximum potential for pedestrian trips. Default: 5.0%
    - *Input sheet name: "S10S11"*

User Inputs

- Percent of additional pedestrian coverage
    - *Input sheet name: "Test"*

Research Used to Support Calculations of Effectiveness

- Percent of employees who walk to work from the CTR database

Factors Not Taken Into Account

- Length of work trip
- Possible limit to work trips
- Existing bicycle and walking use
- Weather, seasons, climate

Assumptions

- The decrease in auto drive alone mode share is proportional to baseline mode shares
- The 85 percentile of walking mode share from the CTR database represented 85 percent of the bicycle mode share that can be expected

12. Restricted Parking Supply

This strategy will include the imposition of maximum parking ratios for future development to where they do not exist and lowering the maximum ratios where they do exist.

Strategy Parameter

The strategy is tested by specifying the maximum parking ratio that would be allowed by the building code for commercial development.

Effectiveness Factor

The effectiveness factor was derived by assuming that when the demand for parking exceeds the supply, some of the excess will diver to other modes. To test this strategy, the TEEM model calculates the expected parking demand by increasing the observed parking demand by the percentage increase in person trips. The supply is calculated by using the specified maximum ratios and the amount of new development that is expected. The predicted supply is compared to the predicted demand and the diversions of trips from auto are calculated on the following basis:

- Demand to supply ratio: 0.75 to 0.85 leads to 25% trips diverted
- Demand to supply ratio: 0.86 to 0.95 leads to 50% trips diverted
- Demand to supply ratio: 0.96 to 1.10 leads to 75% trips diverted
- Demand to supply ratio: greater than 1.10 leads to 90% trips diverted

Sensitivity Factors

- Percent of trips diverted based on demand to supply ratio
    - *Input sheet name: "S12"*

Calculation of Strategy Effect

- Calculate future parking demand assuming a proportional increase based on the baseline growth in vehicle trips to each local traffic analysis zones
- Calculate change in development (floor area) by type, based on the change in predicted employment of each type
- Calculate change in parking supply by applying proposed parking code requirements to forecast growth in development
- Apply vehicle trip reduction (person trip diversion) factors for each local traffic analysis zone based on the expected future year parking V/C ratio for the each local traffic analysis zone
- Subtract all of the reduction in vehicle trips from drive-alone and reallocate to non-auto modes on a proportional bases

Baseline Information

Collected at the Transportation Analysis Zone (TAZ) Level:

- Baseline mode split for HBW attractions
  - *Input sheet names: "2000" and "2030"*
- Population, retail employment and other employment
  - *Input sheet names: "2000" and "2030"*
- Parking supply and demand for retail and other land uses
  - *Input sheet names: "2000" and "2030"*

Collected at the Case Study Area Level:

- Baseline mode split for CTR employers
  - *Input sheet name: "Mode Split Input"*

Collected at the Regional Level:

- Employees per square foot for retail, office and industrial land uses by central-business-district and non-central-business-district
  - *Input sheet name: "Other Model Factor Input"*
- Parking requirement
  - *Input sheet name: "S12-Parking"*

User Inputs

- Percent decrease in the parking requirements
  - *Input sheet name: "Test"*

Research Used to Support Calculations of Effectiveness

- The number of employees per floor area
- The base parking requirements

Factors Not Taken Into Account

- Parking for a development may occur in adjacent zones

Assumptions

- The decrease in auto drive alone mode share is proportional to baseline mode shares
- Growth in demand for parking is proportional to growth in local TAZ attractions

13. Parking Pricing at Employment Sites

This strategy will include charging for parking at employment sites. This may take the form of an elimination of free parking, with the employer requiring some payment for on-site parking, or may include the offering of all parking to the public at a fee with few or no spaces reserved specifically for employees of the building or site.

Strategy Parameter

The strategy is tested by specifying an average daily increase in the parking charge for commute travel. This is above what is modeled by PSRC in 2030.

Effectiveness Factor

- The effectiveness factor was derived from research on the effects of parking charge on auto use conducted by the University of Washington using data from the Puget Sound Region.

Sensitivity Factors

- Elasticity of transit use with respect to average transit fare per trip. Default: -0.15
  - *Input sheet name: "S13"*

Calculation of Strategy Effect

- Percentage change in average daily auto operating costs that would result from a parking charge
- Calculate change in work drive-alone share by applying an elasticity of auto use with respect to auto operating cost to the base drive-alone share

Baseline Information

Collected at the Transportation Analysis Zone (TAZ) Level:

- Baseline mode split for HBW attractions
  - *Input sheet names: "2000" and "2030"*

Collected at the Case Study Area Level:

- Baseline mode split for CTR employers
  - *Input sheet name: "Mode Split Input"*
- Average one-way distance to work for drive alone users
  - *Input sheet name: "Daily Cost Input"*
- Existing and future parking costs for drive alone vehicles
  - *Input sheet name: "Daily Cost Input"*

Collected at the Regional Level:

- None

User Inputs

- Additional parking charge at employment site
  - *Input sheet name: "Test"*

Research Used to Support Calculations of Effectiveness

- Baseline parking and auto operating costs

Factors Not Taken Into Account

- Overflow into neighborhoods

Assumptions

- The decrease in auto drive alone mode share is proportional to baseline mode shares
- A proportional relationship between an increase in the auto operating cost and a decrease in the drive alone made share
- Future (2030) parking charges were taken from the PSRC model

14. FlexPass/Residential Pass

This strategy will include offering a transit pass to all members of a group at a reduced rate. The group may be an employer, all of the employers within a TMA, or a residential neighborhood.

Strategy Parameter

The strategy is tested by specifying the percentage of employees in a study area that would be offered FlexPass or the percentage of residents that would be offered the pass.

Effectiveness Factor

- The effectiveness factor was derived from national research on transit price elasticity.

Sensitivity Factors

- Elasticity of transit use with respect to FlexPass utilization by employees. Default: -0.22
  - *Input sheet name: "S14"*
- Elasticity of transit use with respect to FlexPass utilization by residents. Default: -0.22
  - *Input sheet name: "S14"*

Calculation of Strategy Effect

- Calculate the change in transit share for each trip type for each group offered the pass (work trips only for study area employees offered the pass and work and non-work trips for study area residents offered the pass)

Baseline Information

Collected at the Transportation Analysis Zone (TAZ) Level:

- Baseline mode split for HBW attractions
  - *Input sheet names: "2000" and "2030"*

Collected at the Case Study Area Level:

- Baseline mode split for CTR employers
  - *Input sheet name: "Mode Split Input"*

Collected at the Regional Level:

- Average daily cost to ride transit
  - *Input sheet name: "S14"*
- Percent subsidy
  - *Input sheet name: "S14"*

User Inputs

- Percent of residents or employees offered a flexpass
  - *Input sheet name: "Test"*

Research Used to Support Calculations of Effectiveness

- Elasticity of transit use with respect to FlexPass utilization

Factors Not Taken Into Account

- Induced transit travel resulting from a pre-paid pass (no marginal cost to using the pass)

Assumptions

- The decrease in auto drive alone mode share is proportional to baseline mode shares
- Increase in transit use from FlexPass draws from other modes and is not the result of new trips being made

15. Increased Density Near Transit

This strategy includes the provision of more transit to a zone than is already reflected in the 2030 baseline. The increase in the transit service can be a change in mode such as replacing bus service with light rail service, can be the addition of new service, or can be an increase in the frequency of service.

Strategy Parameter

The strategy is tested by using the definitions of transit service developed for Strategy #7, to determine whether any local traffic analysis zones would have a new classification with respect to transit service with the change being tested. A chance in classification would result in a change in the vehicle trip rates for the trips to and from the zone according to the trip rate index in Table 2.

Effectiveness Factor

See Strategy #7

Sensitivity Factors

- Variation in vehicle trips by population, retail employment, and other employment density
  - *Input sheet names: "Land Use Factors"*

Calculation of Strategy Effect

- Calculate revised future year trip ends by purpose for each local traffic analysis zone using the appropriate rates by transit service, density and mix use ratio categories

- Includes a calculation of associated centroids to estimate the transit service, mixed-use and density of nearby zones

Baseline Information

Collected at the Transportation Analysis Zone (TAZ) Level:

- Baseline mode split for HBW attractions and HBW productions
  - *Input sheet names: "2000" and "2030)*
- Transit level of service
  - *Input sheet names: "2000" and "2030"*
- Area in square miles
  - *Input sheet names: "2000" and "2030"*
- Population, retail employment and other employment
  - *Input sheet names: "2000" and "2030"*

Collected at the Case Study Area Level:

- Baseline mode split for CTR employers
  - *Input sheet name: "Mode Split Input"*

Collected at the Regional Level:

- none

User Inputs

- Change in transit density by transportation analysis zone
  - *Input sheet name: "Test"*

Research Used to Support Calculations of Effectiveness

- Calculation of transit level of service factors for each TAZ based on existing person trips and the existing transit service

Factors Not Taken Into Account

- Non-work trips
- Nature of employment

Assumptions

- The decrease in auto drive alone mode share is proportional to baseline mode shares
- The radius of effectiveness for a TAZ was approximately 1/4 mile beyond its area